TOPOGRAPHY OF THE YUCCA MOUNTAIN SITE

The purpose of this activity is to demonstrate the usefulness of topographic maps and to examine the topography of the Yucca Mountain site by using a U.S. Geological Survey 7-1/2-minute topographic map. By participating in the exercises, you will acquire a detailed knowledge of the Yucca Mountain site and an understanding of the size and depth of the potential repository. You will also use prominent features on the map to aid you in thinking about guidelines for evaluating potential repository sites that apply to hydrology, erosion, population density and distribution, and site ownership and control.

Directions: Use the U.S. Geological Survey 7-1/2-minute topographic map titled Busted Butte, Nevada, 1961, photo-revised 1983 to answer the questions below.

Reviewing Map Skills

1. Determine the scale and contour interval of the map.

   Scale: _____

   Contour interval: _____

2. What does 1" on this map represent on the ground? (Show the answer both in inches and converted to feet.)

   _____

   _____

3. Locate the information that shows the direction of true north and magnetic north on the map. Where is the information located on the map?

   _____

   _____

4. What are the latitude and longitude coordinates of the southeast and northwest corners of the map?

   _____

   _____

5. What is the purpose of the latitude and longitude grid ticks? List each set of grid ticks separately. (See Figure 1.)

_____

_____

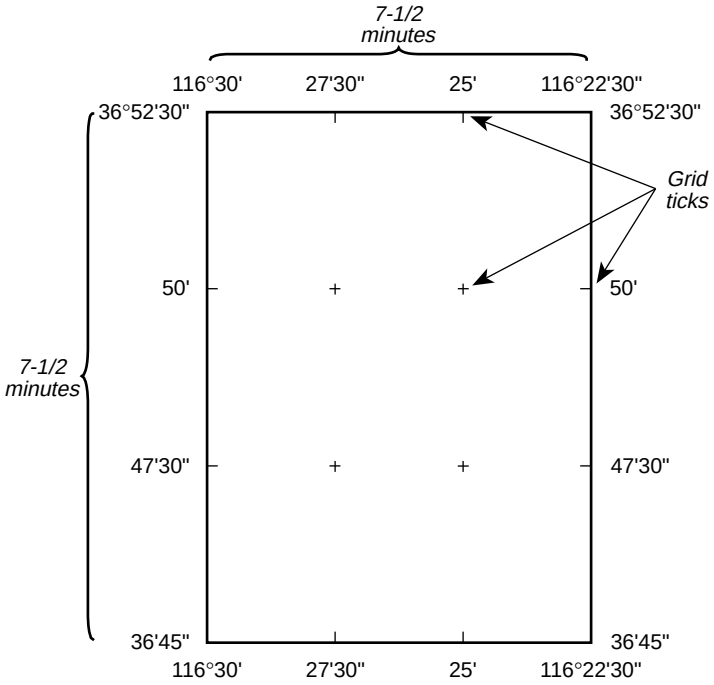
_____

Latitude Grid Ticks:

_____

Longitude Grid Ticks:

_____



Grid ticks divide a 7-1/2-minute map into 2-1/2-minute sections

Figure 1

Part A: Locating A Point On A Topographic Map

Directions: Use the map, an appropriately scaled ruler, and the following latitude/longitude coordinates to locate two points on the map. You will locate each point by finding where a line of latitude and a line of longitude cross.

Point 1: Lat N36° 50' 44", Long W116° 29' 34"

Point 2: Lat N36° 51' 12", Long W116° 23' 28"

Point 1

1. Point 1 falls on Lat N36° 50' 44". Between which orienting points of latitude (grid ticks and/or map borders) does point 1 fall?

_____

Draw a line through the necessary orienting point(s) to separate this section of latitude from the rest of the map. (See Figure 2.)

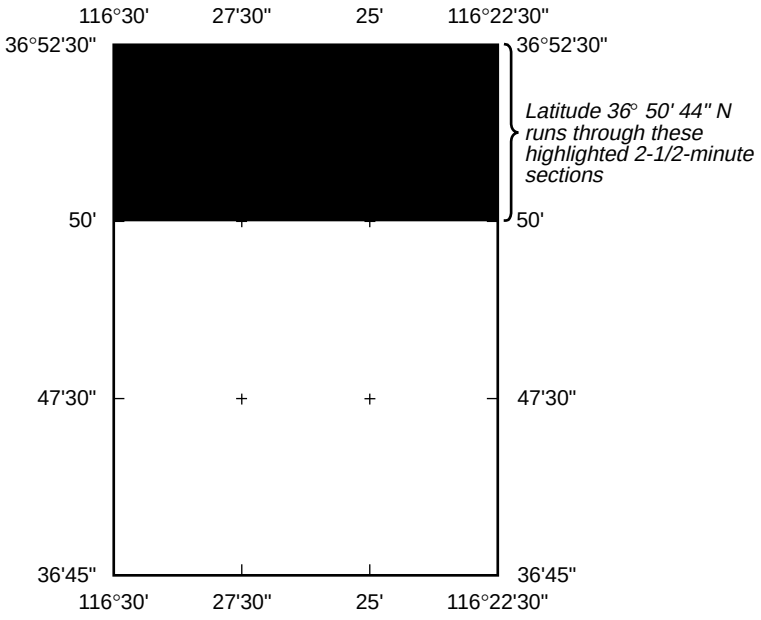


Figure 2

2. Point 1 falls on Long W116° 29' 34". Between which orienting points of longitude does point 1 fall?

_____

_____

Draw a line through the necessary orienting point(s) to separate this section of longitude from the rest of the map. (See Figure 3.)

At this point, one section of the map should be separated from the rest of the map. This section is 1/9th of the whole quadrangle map and it contains point 1. (See Figure 4.)

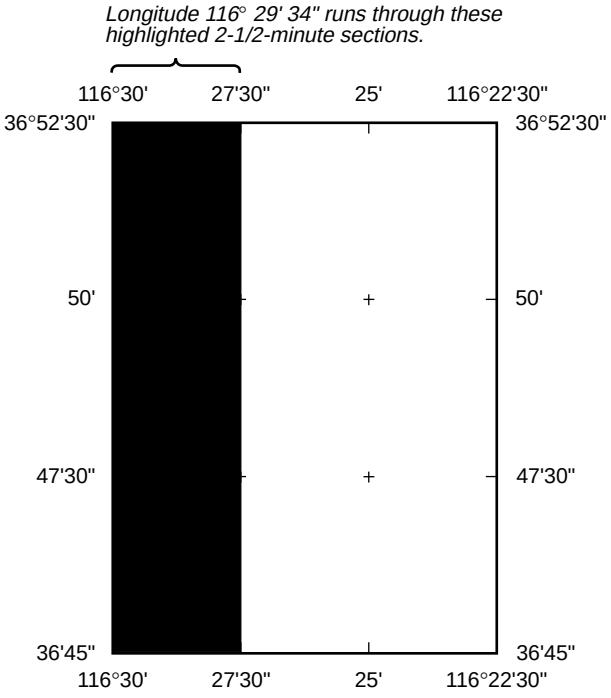


Figure 3

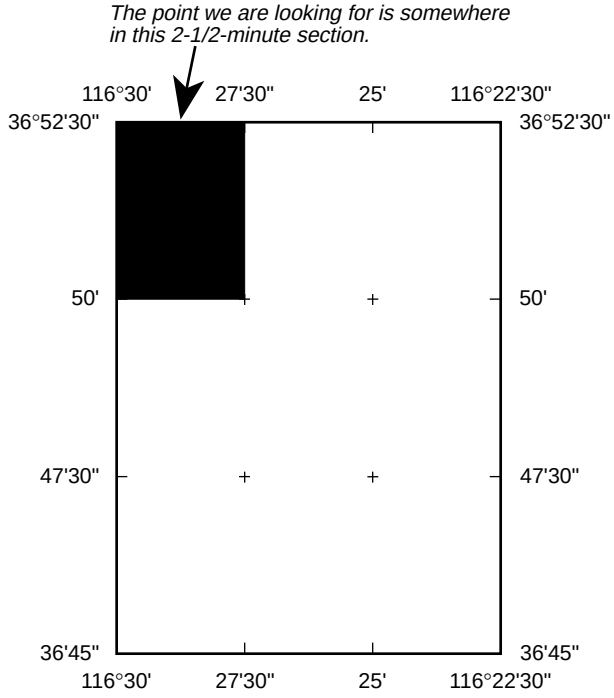


Figure 4

3. In which section of the map will you find point 1?

NW	NC	NE
WC	C	EC
SW	SC	SE

_____

_____

_____

_____

Next Section

4. What are the dimensions of this section of the map in minutes? Convert to seconds.

_____

_____

5. How many seconds north of the N36 ° 50' line of latitude is N36 ° 50' 44"?

_____

_____

6. Use the engineer's rule or cut out the paper engineering ruler provided that has 150 divisions. Since the section of the map that includes point 1 is 2-1/2 minutes by 2-1/2 minutes or 150 seconds by 150 seconds, you will be able to use this ruler to find point one or any unknown point within a section. (Each division equals one second.)

   Using the ruler, locate any two points 44" (44 divisions) north of Lat N50'. You will need to hold the ruler vertically with the 0 mark on Lat N50' and the 150 mark on the top border of the map. (See Figure 5.)

   Connect the points. Point 1 is somewhere on this line.

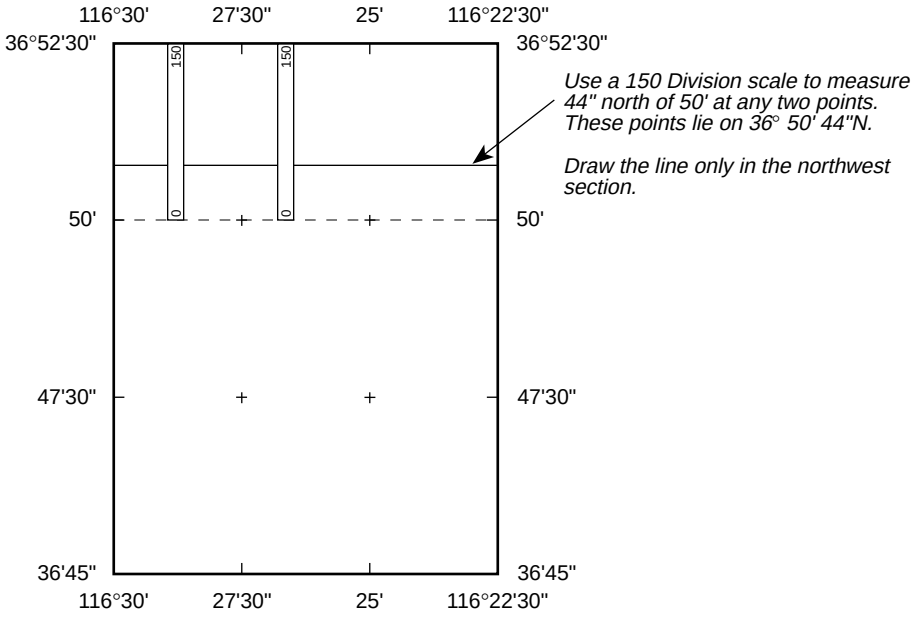


Figure 5

7. How many minutes west of the 27' 30" line of longitude is W116° 29' 24"?

_____

_____

You can subtract distances in degrees, minutes, and seconds but remember that you are working in base 60. One degree is equal to 60 minutes, and one minute is equal to 60 seconds.

8. Using the ruler, locate any two points 124" (124 divisions) west of Long W27' 30". This time you will need to hold the ruler diagonally as illustrated in Figure 6. It is important that you align either the 0 or 150 mark on the ruler with the 27' 30" line. You must align the other division mark (0 or 150) on the western boundary of the map. Count 124" west of 27' 30" and mark a point on the map. Although both ends of the ruler need to be aligned properly, they do not necessarily need to fall within the boundaries you have drawn for this section. Move the ruler, align it again, and make a second mark.

   Connect the two points making sure the line that connects them extends through the NW section of the map. Point 1 is where the line of longitude crosses the line of latitude you drew in step 6.

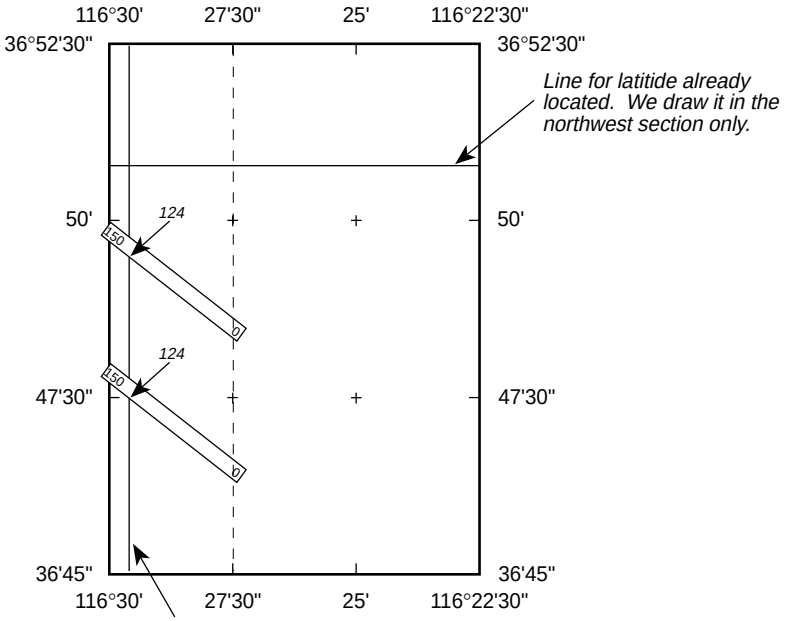


Figure 6

Point 2

9. Use the same approach to locate point 2.

   Using a blue pencil, connect points 1 and 2.

Next Section

Part B: Drawing A Topographic Profile

If we could cut the Earth in half along the line that connects points 1 and 2, and then look at the planet's profile, we could clearly see peaks and valleys and get a good three-dimensional view of the topography of the land in this area. A much simpler way to gather the same information from a two dimensional drawing is to construct a topographic profile.

1. What is the contour interval on your Busted Butte, Nevada, map?

_____

2. Using a sheet of paper that is at least 15" long on one side, align it so that the edge of the paper lines up with the line connecting points 1 and 2. (If necessary, tape two 8 1/2" x 11" sheets together.)

3. Make a mark on the paper where every dark brown (100) contour line crosses the line connecting points 1 and 2. (See Figure 7.) Record each line's elevation next to each mark. You may need to follow some contour lines quite a distance to determine their elevation. Where 100 contour lines are great distances apart, mark all others to get a greater degree of accuracy in your profile. Also record the location of jeep trails or roads where they cross the line of section.

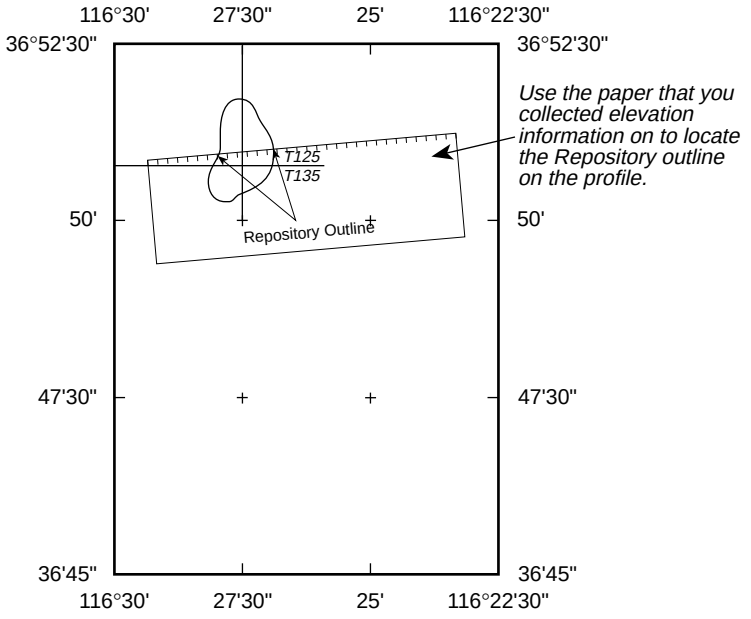
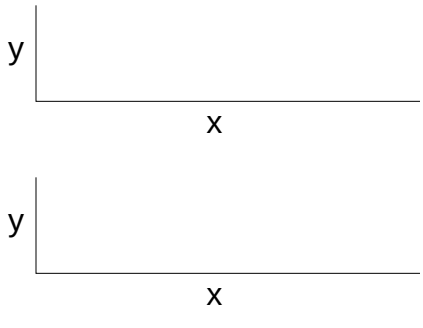


Figure 7

4. Tape two pieces of graph paper together so that the length of one edge is at least 15".

5. Draw two x and y axes on the graph paper as indicated below. The x-axis will represent the distance from point 1 to 2. The y-axis will represent different scales for each graph. One graph



will have a scale of 1" = 500' while the other will have a scale of 1" = 2000'.

6. Line up the piece of paper that shows where contour lines cross the line connecting points 1 and 2, with the X-axis of your first graph as indicated below. At each mark along the X-axis, make a mark, at the appropriate elevation, as read on the y-axis. Do this for all points. Then connect the dots using a smooth line.

7. Repeat this procedure for the second graph using the second scale.

   What effect does the different vertical scale have on each profile?

   _____

   _____

   Which profile appears more like it would naturally occur?

   _____

   _____

   Which profile emphasizes the subtle aspects of the surface along the profile by showing more details of the landscape?

   _____

   _____

8. A pattern that represents the outline of the underground repository as it might appear in a final design is included. Cut out the pattern and use the lines drawn on the cut-out to locate it on the map. Transfer the shape to the map using a blue pencil. Now plot the locations on the topographic profile where the repository outline intersects the profile.

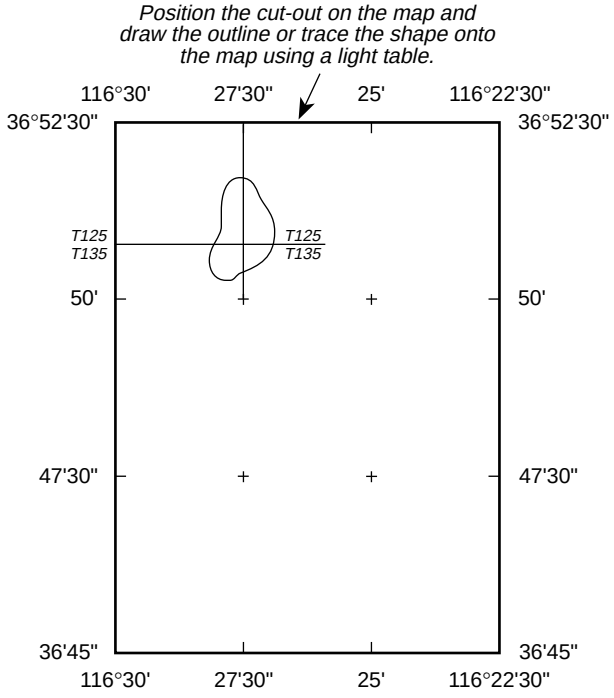
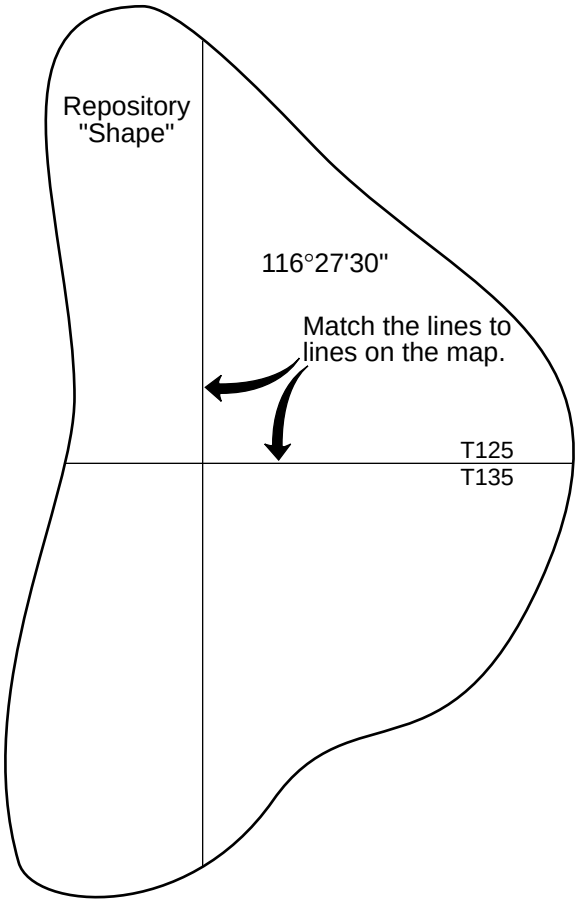


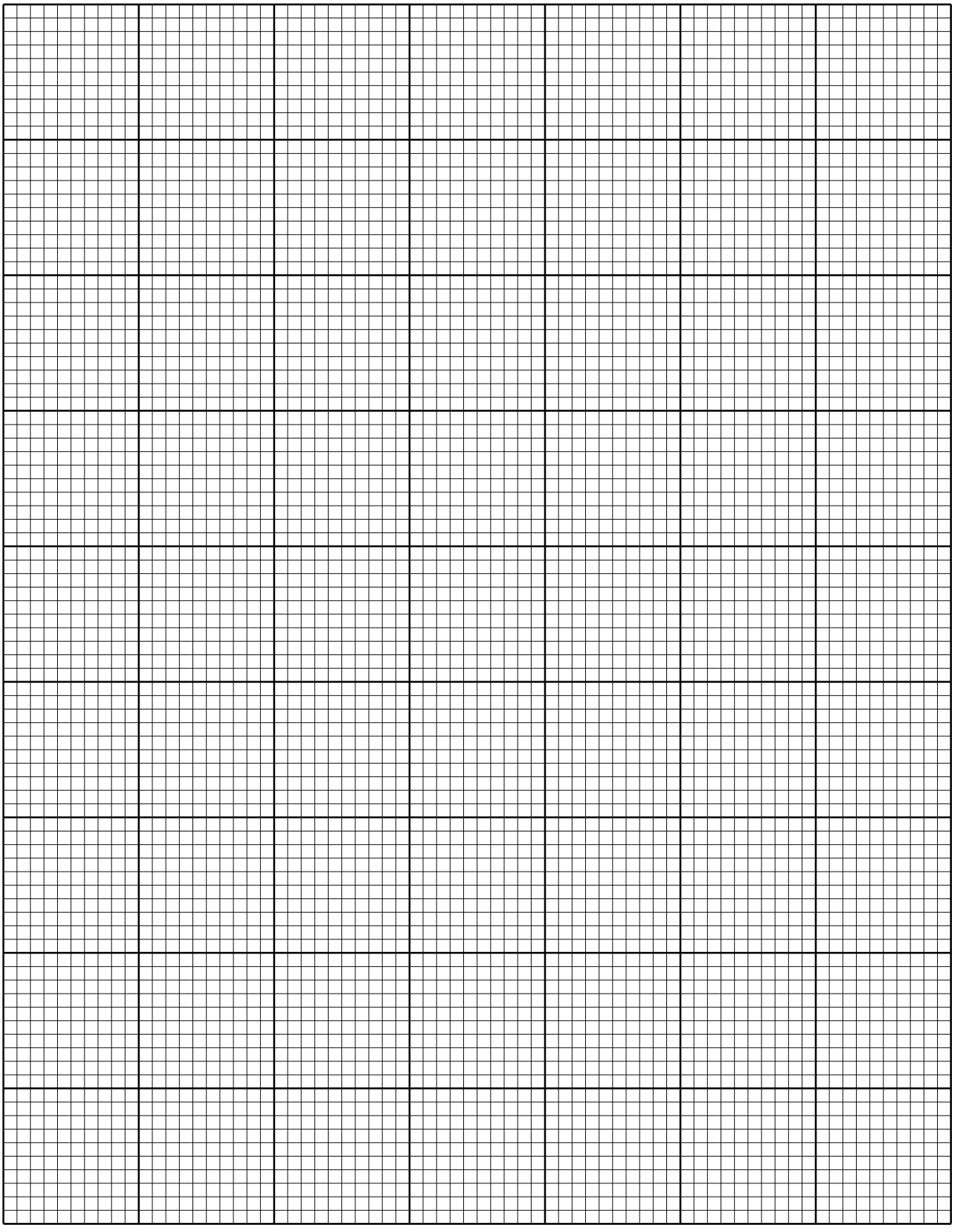
Figure 8

Next Section



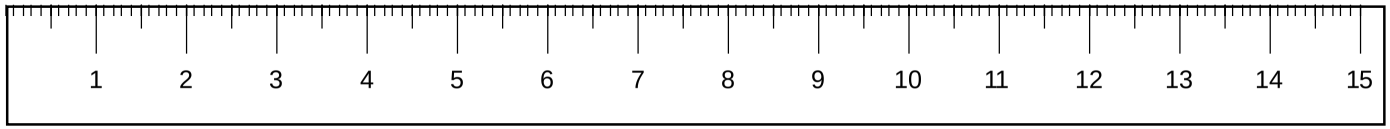
Cut out and locate on map at the intersection of 116° 27' 30" and township boundary line.

Next Section

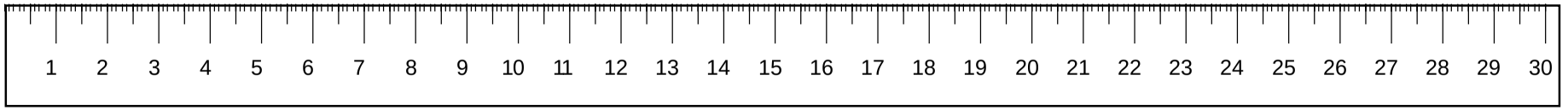


Next Section

If an engineers scale is unavailable, this paper scale can be used to construct a topographical profile and determine latitude and longitude coordinates of points on the map. Note that each number on the scale represents 10. To use, fold along line with marks.



(Use 150 divisions for a 7-1/2-minute map.)



(Use 300 divisions for a 15-minute map.)

Next Section

CONSIDERATIONS FOR SITING THE HIGH-LEVEL NUCLEAR WASTE REPOSITORY

Siting the Nation's first high-level nuclear waste repository is a very complicated project. Research personnel need to consider such factors as *geochemistry* (the chemical composition and possible chemical changes in the Earth's crust), *geohydrology* (the character and source of ground water), rock characteristics, climate, tectonics, human interference, population density and distribution, site ownership and control, meteorology, environmental quality, socioeconomic impacts, transportation, and the presence of natural resources. The goal of the site characterization studies is to determine if Yucca Mountain, the proposed site for the repository, will be suitable to protect the surrounding environment from dangerous levels of radiation for 10,000 years after the repository is closed.

Although developing a thorough understanding of even one of these factors is very complicated and takes many years, some very useful information can be gathered from a topographic map of the area. During this activity you will use your topographic profile and your United States Geological Survey map of the Busted Butte Quadrangle to take a first hand look at some of the factors relating to repository siting: 1) erosion, 2) ground water and geochemistry, 3) population density and distribution, and 4) site ownership and control.

Next Section

EROSION

Directions: Read the excerpt from *General Guidelines for the Recommendation of Sites for the Nuclear Waste Repositories: Final Siting Guidelines,* below, using it to answer the questions that follow.

960.4-2-5 Erosion

(a) *Qualifying Condition.*

The site shall allow the underground facility to be placed at a depth such that erosional processes acting upon the surface will not be likely to lead to radionuclide releases greater than those allowable under the requirement specified in Guideline 960.4-1. In predicting the likelihood of potentially disruptive erosional processes, the DOE will consider the climatic, tectonic, and geomorphic evidence of rates and patterns of erosion in the geologic setting during the Quarternary Period.

(b) *Favorable Conditions.*

(1) Site conditions that permit the emplacement of waste at a depth of at least 300 meters below the directly overlying ground surface.

(2) A geologic setting where the nature and rates of the erosional processes that have been operating during the Quarternary Period are predicted to have less than one chance in 10,000 over the next 10,000 years of leading to releases of radionuclides to the accessible environment.

(3) Site conditions such that waste exhumation would not be expected to occur during the first one million years after repository closure.

(c) *Potentially Adverse Conditions.*

(1) A geologic setting that shows evidence of extreme erosion during the Quarternary Period.

(2) A geologic setting where the nature and rates of geomorphic processes that have been operating during the Quarternary Period could, during the first 10,000 years after closure, adversely affect the ability of the geologic repository to isolate the waste.

(d) *Disqualifying Condition.*

The site shall be disqualified if site conditions do not allow all portions of the underground facility to be situated at least 200 meters below the directly overlying ground surface.

1. What is the lowest ground surface elevation along your topographical profile within the possible repository boundary?

_____

_____

2. According to Favorable Condition (1) above, how deep should the repository be in meters? How many feet is this? (Remember that 1 meter = 3.28 feet.)

_____

_____

3. At what depth within the possible repository boundary could the repository be built to satisfy Favorable Condition (1)? Draw a line on your topographical profiles to represent this placement of the repository.

_____

_____

4. According to the Disqualifying Condition above, what is the minimum allowable depth for the repository in meters? How many feet is this?

_____

_____

5. At what depth within the possible repository boundary could the repository be built to satisfy the Disqualifying Condition? Draw a line on your topographical profiles to represent this placement of the repository.

_____

_____

6. Calculate the maximum rate of erosion that would uncover a repository at a depth of 200 meters, and a repository at 300 meters, during a time span of 10,000 years.

_____

_____

_____

_____

Next Section

GROUND WATER

1. According to a hydrologic atlas published by the U.S. Geological Survey:

   1) The State of Nevada has a mean precipitation of 22.9 centimeters (9 inches) per year, the lowest statewide mean in the United States.
   2) An average of less than 2.5 centimeters (1 inch) of this precipitation either recharges aquifers or runs off.
   3) In 84 percent of the State, drainage is to low areas in enclosed basins rather than to the sea. Flow in the larger rivers generally decreases downstream as water is lost to evaporation and infiltration.

Directions: Use these three facts and the topographic map, as necessary, to answer the questions below.

a. Of the 22.9 centimeters (9 inches) of annual precipitation, how much is evaporated?

_____

_____

b. Examine the topographic map looking for evidence of running water (runoff). What do you think the blue, dashed and dotted lines represent?

_____

_____

c. Look at the area east of Yucca Mountain toward Fortymile Canyon and Fortymile Wash. What happens to runoff from Yucca Mountain when it reaches Fortymile Wash, southeast of Busted Butte?

_____

_____

_____

_____

d. Explain why you think flow decreases downstream, rather than increases, in this area of the country.

_____

_____

e. Use an almanac or other reference book to find the mean annual precipitation for the State of South Carolina. What is the annual precipitation? Why do you think streams and rivers flow continuously in this State even during long periods without rainfall?

_____

_____

_____

_____

2. One of the important considerations in siting the repository is the elevation of the water table. The water table separates the saturated zone from the unsaturated zone. Examine figure 10, which shows how water is obtained from wells drilled into the saturated zone beneath the surface of the ground. Assume Figure 10 represents conditions as they exist in this part of Nevada. Now look in the Southeast corner of the Busted Butte topographic map for Well J-12. At what surface elevation is Well J-12? Based on the evidence provided by the topographic map alone, what is the maximum depth of the water table in this region?

_____

_____

3. What are other indications of the depth of the water table?

_____

_____

Next Section

4. Do any of the items you listed in question 3 suggest that the water table is deeper than what was suggested by the location of Well J-12?

_____

_____

5. Using the water table elevation that you determined in question 2, draw a line at this elevation across the entire length of the topographic profiles that you prepared and label it *"MAXIMUM POSSIBLE WATER TABLE ELEVATION BASED ON WELL J-12."*

6. What assumptions are we making when we draw this line?

_____

_____

_____

_____

7. How certain are you that this line represents a real water table elevation?

_____

_____

8. Why draw this line at all?

_____

_____

9. How would you obtain a much more precise value for the elevation of the water table in the vicinity of Well J-12? How would you obtain a much more precise depth for the water table along the topographic profile that you drew?

_____

_____

_____

Directions: Read the excerpt from *General Guidelines for the Recommendation of Sites for the Nuclear Waste Repositories: Final Siting Guidelines,* below, using it to answer the questions that follow.

960.4-2-1 Geohydrology

(a) *Qualifying Condition.*

The present and expected geohydrologic setting of a site shall be compatible with waste containment and isolation. The geohydrologic setting, considering the characteristics of and the processes operating within the geologic setting, shall permit compliance with

(1) the requirements specified in 960.4-1 for radionuclide releases to the accessible environment and

(2) the requirements specified in 10 CFR 60.113 for radionuclide releases from the engineered-barrier system using reasonably available technology.

(b) *Favorable Conditions.*

(1) Site conditions such that the pre-waste-emplacement ground-water travel time along any path of likely radionuclide travel from the disturbed zone to the accessible environment would be more than 10,000 years.

(2) The nature and rates of hydrologic processes operating within the geologic setting during the Quaternary Period would, if continued into the future, not affect or would favorably affect the ability of the geologic repository to isolate the waste during the next 100,000 years.

(3) Sites that have stratigraphic, structural, and hydrologic features such that the geohydrologic system can be readily characterized and modeled with reasonable certainty.

(4) For disposal in the saturated zone, at least one of the following pre-waste-emplacement conditions exist:
   (i) A host rock and immediately surrounding geohydrologic units with low hydraulic conductivities.
   (ii) A downward or predominantly horizontal hydraulic gradient in the host rock and in the immediately surrounding geohydrologic units.
   (iii) A low hydraulic gradient in and between the host rock and immediately surrounding geohydrologic units.
   (iv) High effective porosity together with low hydraulic conductivity in the rock units along paths of likely radionuclide travel between the host rock and accessible environment.

(5) For disposal in the unsaturated zone, at least one of the following pre-waste-emplacement conditions exists:
   (i) A low and nearly constant degree of saturation in the host rock and in the immediately surrounding geohydrologic units.
   (ii) A water table sufficiently below the underground facility such that the fully saturated voids continuous with the water table do not encounter the host rock.
   (iii) A geohydrologic unit above the host rock that would divert the downward infiltration of water beyond the limits of the emplaced waste.
   (iv) A host rock that provides for free drainage.

(v) A climatic region in which the average annual historical precipitation is a small fraction of the average annual potential evapotranspiration.

(c) *Potentially Adverse Conditions.*

(1) Expected changes in geohydrologic conditions—such as changes in the hydraulic gradient, the hydraulic conductivity, the effective porosity, and the ground water flux through the host rock and the surrounding geohydrologic units—sufficient to significantly increase the transport of radionuclides to the accessible environment as compared with pre-waste-emplacement conditions.

(2) The presence of ground water source, suitable for crop irrigation or human consumption without treatment, along ground water flow paths from the host rock to the accessible environment.

(3) The presence in the geologic setting of stratigraphic or structural features—such as dikes, sill, faults, shear zones, folds, dissolution effects, or brine pockets—if their presence could significantly contribute to the difficulty of characterizing or modeling the geohydrologic system.

(d) *Disqualifying Condition.*

A site shall be disqualified if the pre-waste-emplacement ground water travel time from the disturbed zone to the accessible environment is expected to be less that 1,000 years along any pathway of likely and significant radionuclide travel.

10. Pretend that the water table elevation on your topographic profile is accurate. Do you think the repository elevations on your profile are favorable according to the geohydrology guidelines?

_____

_____

_____

_____

11. Section (b)(5) lists pre-waste-emplacement conditions for the unsaturated zone. Which, if any, of these conditions exist at Yucca Mountain according to your profile and the information you have acquired in this activity? Explain your answers.

_____

_____

_____

_____

12. Based on your calculated water table, if the repository were sited for an elevation of 1,021 meters (3,350 feet), would it be located in the saturated or unsaturated zone?

_____

13. Would a repository at 1,021 meters (3,350 feet) conflict with the erosion or the geohydrology guidelines? Why or why not?

_____

_____

14. Based on your determined water table, if the repository were sited for an elevation of 2,900 feet, would it be located in the saturated or unsaturated zone?

_____

_____

15. Would a repository at 884 meters (2,900 feet) conflict with either the erosion or the geohydrology guidelines? Why or why not?

_____

_____

16. Suppose you had to choose between putting the repository at 1,021 meters (3,350 feet) or at 884 meters (2,900 feet) and assume that the water table elevation on your profile is accurate. In making your decision, how would you balance the requirements of the erosion and geohydrology guidelines?

_____

_____

_____

_____

The water table under Yucca Mountain occurs in the fractured tuff of the Calico Hills or the Crater Flat units; it slopes to the southeast from an elevation of 792 to 732 meters (2,600 to 2,400 feet) above sea level. Current estimates are that only a small part of the rain that falls on Yucca Mountain percolates through the matrix of the unsaturated zone. The regional direction of ground water flow is south to southwest. As elsewhere in the southern Great Basin, the ground water basins tend to be closed, with no external drainage into rivers or major bodies of surface water. (Source: Consultation Draft Site Characterization Plan Overview Yucca Mountain Site, Nevada Research and Development Area, Nevada DOE/RW-0161, 1988.)

Next Section

POPULATION DENSITY AND DISTRIBUTION

Directions: Read the excerpt from *General Guidelines for the Recommendation of Sites for the Nuclear Waste Repositories: Final Siting Guidelines,* below, using it to answer the questions that follow.

960.5-2-1 Population Density and Distribution

(a) *Qualifying Condition.*

The site shall be located such that, during repository operation and closure,

(1) the expected average radiation dose to members of the public within any highly populated area will not be likely to exceed a small fraction of the limits allowable under the requirements specified in 960.5-1(a)(1), and

(2) the expected radiation dose to any member of the public in an unrestricted area will not be likely to exceed the limit allowable under the requirements specified in 960.5-1(a)(1).

(b) *Favorable Conditions.*

(1) A low population density in the general region of the site.

(2) Remoteness of site from highly populated areas.

(c) *Potentially Adverse Conditions.*

(1) High residential, seasonal, or daytime population density within the projected site boundaries.

(2) Proximity of the site to highly populated areas, or to areas having at least 1,000 individuals in an area 1 mile by 1 mile as defined by the most recent decennial count of the U.S. census.

(d) *Disqualifying Conditions.*

A site shall be disqualified if-

(1) Any surface facility of a repository would be located in a highly populated area; or

(2) Any surface facility of a repository would be located adjacent to an area 1 mile by 1 mile having a population of not less than 1,000 individuals as enumerated by the most recent U.S. census; or

(3) The DOE could not develop an emergency preparedness program which meets the requirements specified in DOE Order 5500.3 (Reactor and Non-Reactor Facility Emergency Planning, Preparedness, and Response Program for Department of

Energy Operations) and related guides or, when issued by the NRC, in 10 CFR Part 60, Subpart I, "Emergency Planning Criteria."

1. Nevada has a 1980 population of 799,000 and a land area of 109,889 square miles. What is the population density of the State?

_____

_____

2. According to the population density guidelines sections (a) and (b), what other information would you need to determine if the Yucca Mountain site is in a region of low population density?

_____

_____

3. Examine the topographic map for habitable structures and estimate the population density of the area covered by the map. (The area of the map is approximately 59 square miles.)

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

SITE OWNERSHIP AND CONTROL

Directions: Read the excerpt from the *General Guidelines for the Recommendation of Sites for the Nuclear Waste Repositories: Final Siting Guidelines,* below, using it to answer the questions that follow.

960.5-2-2 Site Ownership and Control.

(a) *Qualifying Condition.*

The site shall be located on land for which the DOE can obtain, in accordance with the requirements of 10 CFR 60.121, ownership, surface and subsurface rights, and control of access that are required in order that surface and subsurface activities during repository operation and closure will not be likely to lead to radionuclide releases to an unrestricted area greater than those allowable under the requirements specified in 960.5-1(a)(1).

(b) *Favorable Condition.*

Present ownership and control of land and all surface and subsurface mineral and water rights by DOE.

(c) *Potentially Adverse Condition.*

Projected land-ownership conflicts that cannot be successfully resolved through voluntary purchase-sell agreements, nondisputed agency-to-agency transfers of title, or Federal condemnation proceedings.

1. Who controls most of the land area of the Busted Butte Quadrangle map?

_____

_____

2. Can you determine the ownership of all of the land area on the map?

_____

3. Will the proposed repository site meet the ownership and control guidelines? Why or why not?

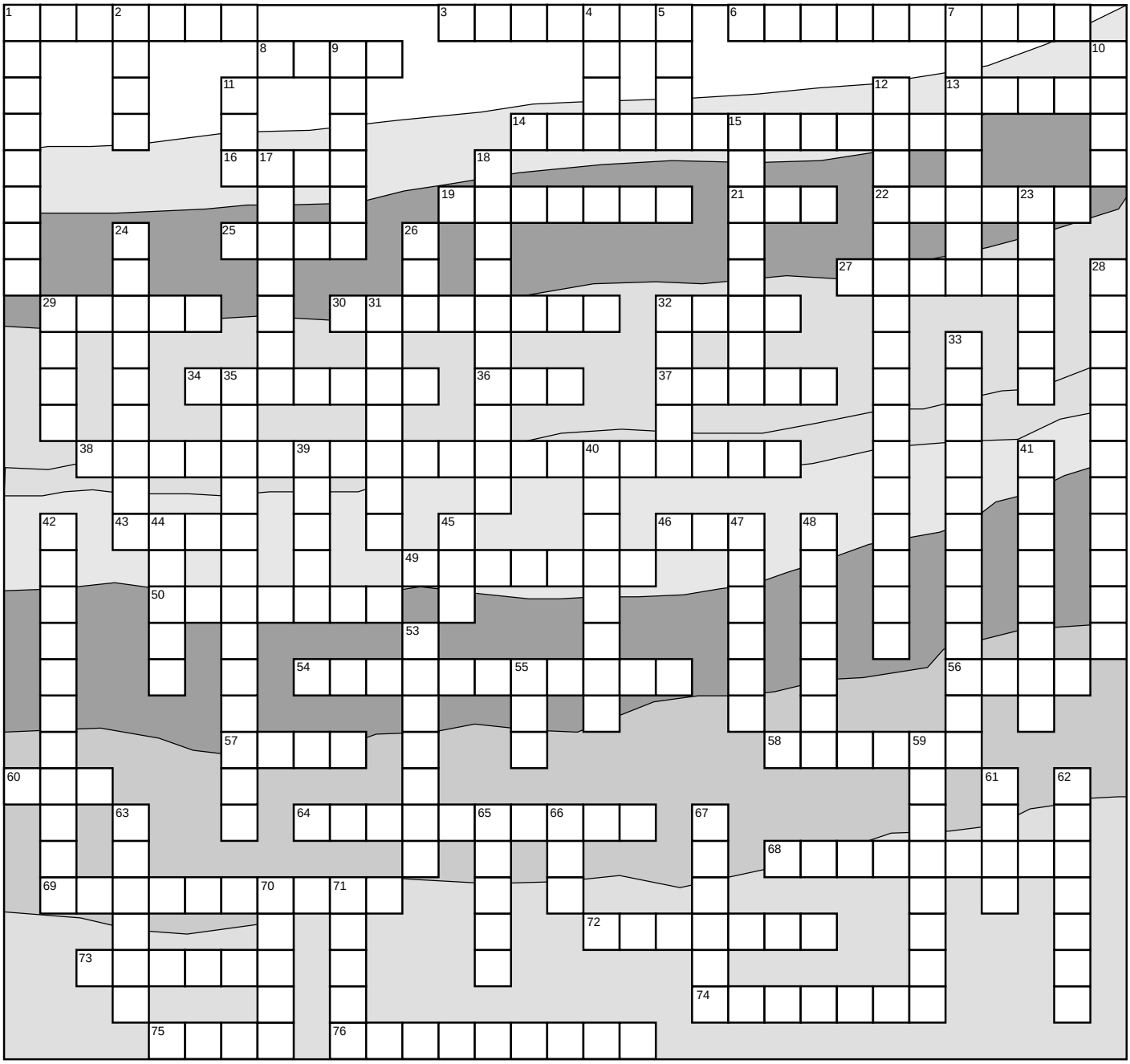
_____

_____

_____

Next Section

CROSSWORD PUZZLE



ACROSS

1. A transportation cask is exposed to a jet fuel fire to test its _____ properties.
3. Microwave ovens are a _____ source of radiation.
6. When the repository reaches its capacity, the shafts will be plugged, _____ and sealed.
8. The primary protection against radiation exposure during transportation.
13. One of four tests administered on a cask: _____ immersion.
14. Most high-level waste must be handled by _____. (2 words)
16. The rock type being studied at Yucca Mountain.
19. A hollow metal tube in which fuel pellets are sealed. (2 words)
21. The government agency that certifies casks. (abbr.)
22. The State in which Yucca Mountain is located.
25. One source of natural background radiation is from cosmic _____.
27. When neutrons split the _____ of atoms, energy is released.
29. A radioactive gas that results from the decay of radium.

Next Section

30. A secondary external packaging that may be used to surround the waste canister.
32. Yucca Mountain is the _____ currently being studied for the repository.
34. These will be used to note the location and significance of the repository.
36. The Nuclear Waste Policy Act is a _____.
37. The repository will be located about 1,000 feet beneath the surface of the _____.
38. Detailed studies being performed at Yucca Mountain. (2 words)
43. Directs DOE to site, design, construct, and operate a geologic repository. (abbr.)
46. Measures the effect on human tissue from a dose of radiation. (abbr.)
49. Drifts
50. A facility will be built deep underground for permanent _____ of the waste.
54. Putting into position for permanent storage.
56. Radiation that can be stopped by a thin sheet of aluminum.
57. The repository will cover an _____ of about 5,700 acres.
58. An unstable atom releases _____ in the form of either electromagnetic waves or fast-moving particles.
60. Radon is a radioactive _____.
64. Uses uranium to generate electricity.
68. _____-_____ waste loses radioactivity rapidly.
69. Spent fuel and defense high-level nuclear waste will be disposed of in a _____.
72. _____ waste results from using radioactive material.
73. One type of carrier that may be used to transport waste to the repository.
74. The fuel for a nuclear powerplant consists of _____ pellets of uranium.
75. Through 1990, about 22,000 metric _____ of spent fuel were in storage.
76. High-level waste is handled behind protective _____.

DOWN

1. The byproducts of mining and milling uranium.
2. Waste may be shipped by truck, barge, or _____.
4. When an unstable _____ changes to a different form, the process is called radioactive decay.
5. Spent fuel will _____ some radiation for thousands of years.
7. _____-_____ waste results from many commercial, medical, and industrial processes.
9. Vertical _____ will be constructed at the repository for ventilation, personnel and equipment use.
10. Type of test administered on a cask: free _____.
11. When spent fuel is remove from the reactor, it is thermally _____.
12. Consists of elements with atomic numbers higher than uranium's. (2 words)
15. For disposal, fuel rods are placed in a _____.
17. The fuel for nuclear reactors.
18. Each of these is about the size of your fingertip. (2 words)
23. Tunnels.
24. There are three types of ionizing _____.
26. The U.S. government agency responsible for disposing of spent fuel and defense high-level nuclear waste. (abbr.)
28. The waste will be stored in a repository to isolate is from the _____.
29. Used in transporting the waste from the surface to the underground facility at the repository.
31. Tuff is formed from the eruption of a _____.
32. Used fuel is called _____ fuel.
33. Contains fuel rods. (2 words)
35. The site being studied for the geologic repository. (2 words)
39. The most energetic, but least penetrating form of radiation.
40. A group of minerals within tuff that have the capability to remove radioactive materials from water.
41. Regional organizations formed to dispose of low-level waste.
42. _____ _____ flow at Yucca Mountain will be studied extensively.
44. Nuclear _____ will be stored deep underground in a repository.
45. A natural source of radiation.
47. The current amount of radioactive waste is measured in _____ tons.
48. The remains of split atoms: _____ products.
53. Before closure of the repository, the shafts will be _____, backfilled, and sealed.
55. Environmental Protection Agency. (abbr.)
59. Radioactive waste will be disposed of in a _____ repository.
61. The fluid resulting from a volcanic eruption.
62. Low-level waste includes items such as rags and _____.
63. _____, resins, and discarded protective clothing are also low-level radioactive waste.
65. Spent fuel is stored in concrete _____ filled with water at reactor sites.
66. Tuff is composed of compacted _____ produced by volcanoes.
67. State, local government and _____ participation are provided for by the NWPA and Amendments Act.
70. A cask must pass a series of _____ before it can be certified.
71. Spent fuel and high-level waste are handled by remote control in shielded _____ to protect workers.